

What is claimed is:

1. A method of determining whether a printed-image-under-examination (PIUE) is a copy of an original printed image, the method comprising:

(a) scanning the PIUE to generate scanned image data, the scanned image data comprising pixel data, the pixel data comprising gray scale values and representing the PIUE as a set of scanning pixels;

(b) forming a plurality of data blocks from the scanned image data, each data block consisting of pixel data which corresponds to a respective region of the PIUE;

(c) transforming the pixel data in at least some of the data blocks to obtain transform domain data;

(d) applying a watermark detecting operation to the transform domain data for respective ones of the data blocks to generate recovered watermark data; and

(e) determining a correlation between the recovered watermark data for at least some of the data blocks and brightness levels for said data blocks.

2. The method according to claim 1, further comprising:

(f) determining that the PIUE is a copy of the original printed image if a strength of the recovered watermark data is negatively correlated with the brightness levels for said data blocks.

3. The method according to claim 1, wherein step (c) includes applying at least one of a Fourier transform, a fast Fourier transform, a discrete cosine transform (DCT) and a

wavelet transform to the pixel data in the at least some of the data blocks to obtain the transform domain data.

4. The method according to claim 1, wherein the watermark detecting operation includes multiplying the transform domain data with a detecting function.

5. The method according to claim 4, wherein the detecting function is e^{ikr} , where k and r are phase space indices applicable to the transform domain data.

6. The method according to claim 4, wherein the detecting operation further includes applying an envelope function to the transform domain data that has been multiplied by the detecting function.

7. The method according to claim 6, wherein the detecting operation further includes applying an inverse transform to the transform domain data that has been multiplied by the detecting function and to which the envelope function has been applied.

8. The method according to claim 1, wherein the PIUE is part of a postal indicia.

9. The method according to claim 1, wherein the regions of the PIUE to which the data blocks correspond are at least partially overlapping with each other.

10. A method of determining whether a printed-image-under-examination (PIUE) is a copy of an original printed image, the original printed image including a watermark applied to the image using a plurality of wave vectors, the method comprising:

(a) scanning the PIUE to generate scanned image data, the scanned image data comprising pixel data, the pixel data comprising gray scale values and representing the PIUE as a set of scanning pixels;

(b) forming a plurality of data blocks from the scanned image data, each data block consisting of pixel data which corresponds to a respective region of the PIUE;

(c) transforming the pixel data in at least some of the data blocks to obtain transform domain data;

(d) applying a watermark detecting operation to the transform domain data for respective ones of the data blocks to generate recovered watermark data; and

(e) determining at least one of (i) a correlation between the recovered watermark data for at least some of the data blocks and brightness levels for said data blocks, and (ii) a correlation between the recovered watermark data and the wave vectors.

11. The method according to claim 10, further comprising:

(f) determining that the PIUE is a copy of the original printed image if a strength of the recovered watermark data is negatively correlated with the brightness levels for said data blocks.

12. The method according to claim 10, further comprising:

(f) determining that the PIUE is a copy of the original printed image if a strength of the recovered watermark data is positively correlated with wavelengths of the wave vectors.

13. The method according to claim 10, wherein step (c) includes applying at least one of a Fourier transform, a fast Fourier transform, a discrete cosine transform (DCT) and a wavelet transform to the pixel data in the at least some of the data blocks to obtain the transform domain data.

14. The method according to claim 10, wherein the watermark detecting operation includes multiplying the transform domain data with a detecting function.

15. The method according to claim 14, wherein the detecting function is e^{ikr} , where k and r are phase space indices applicable to the transform domain data.

16. The method according to claim 14, wherein the detecting operation further includes applying an envelope function to the transform domain data that has been multiplied by the detecting function.

17. The method according to claim 16, wherein the detecting operation further includes applying an inverse transform to the transform domain data that has been multiplied by the detecting function and to which the envelope function has been applied.

18. The method according to claim 10, wherein the PIUE is part of a postal indicia.
19. The method according to claim 10, wherein the regions of the PIUE to which the data blocks correspond are at least partially overlapping with each other.
20. A method of applying a watermark to an image, the method comprising;
- (a) providing image data that represents the image;
 - (b) providing a message string that includes a plurality of message bits;
 - (c) arraying the message bits of the message string at points of a D4 lattice, the lattice being formed as a product of a two-dimensional position-domain lattice and a two-dimensional frequency-domain lattice;
 - (d) generating watermark image data by convolving each of the message bits with a respective watermark function in accordance with a position of the respective bit in the D4 lattice; and
 - (e) combining the watermark image data with the image data provided at step (a) to generate combined image data.
21. The method according to claim 20, further comprising:
- (f) transforming pixel values of the combined image data.
22. The method according to claim 21, further comprising:
- (g) printing an image using the transformed pixel values resulting from step (f).

23. The method according to claim 20, wherein step (c) is performed such that the message bits are arrayed only at lattice points having indices that sum to an even number.

24. The method according to claim 20, wherein step (c) is performed such that the message bits are arrayed only at lattice points having indices that sum to an odd number.

25. The method according to claim 20, wherein each of the watermark functions is formed by multiplying a sinusoid with an envelope function.